

Reduction of Water Use in Wet FGD Systems

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Introduction

- **Project Goal** – Demonstrate the use of heat exchange to reduce flue gas temperature and evaporative water consumption in wet FGD systems. Additional potential benefits for new and retrofit applications:
 - Improve ESP performance: reduced gas volume & improved ash resistivity
 - Reduced gas volume results in smaller FGD system and stack requirements
 - Control SO₃ emissions through condensation on ash
 - Avoid need to install wet stacks or provide flue gas reheat
 - Potential to use recovered heat to increase turbine output (alternative)
 - Potential to increase Hg removal across ESP and FGD system
- **Technical Approach** – Conduct pilot scale tests of integrated air pollution control (APC) system, determine heat exchanger corrosion rates in long-term tests, and assess benefits and costs.
- **Expected Benefits** – Reduced FGD system water consumption, improved APC performance, and reduced capital and O&M costs.

Presentation Outline

- Background on FGD water consumption
- Effects of lower gas temperature on APC system
- Project team
- Technical approach
 - Pilot Testing of Integrated APC systems
 - Pilot Testing of Corrosion in Heat Exchanger
 - Assess Benefits and Costs of Regenerative Heat Exchange
- Schedule

Background – Water Consumption in FGD Systems

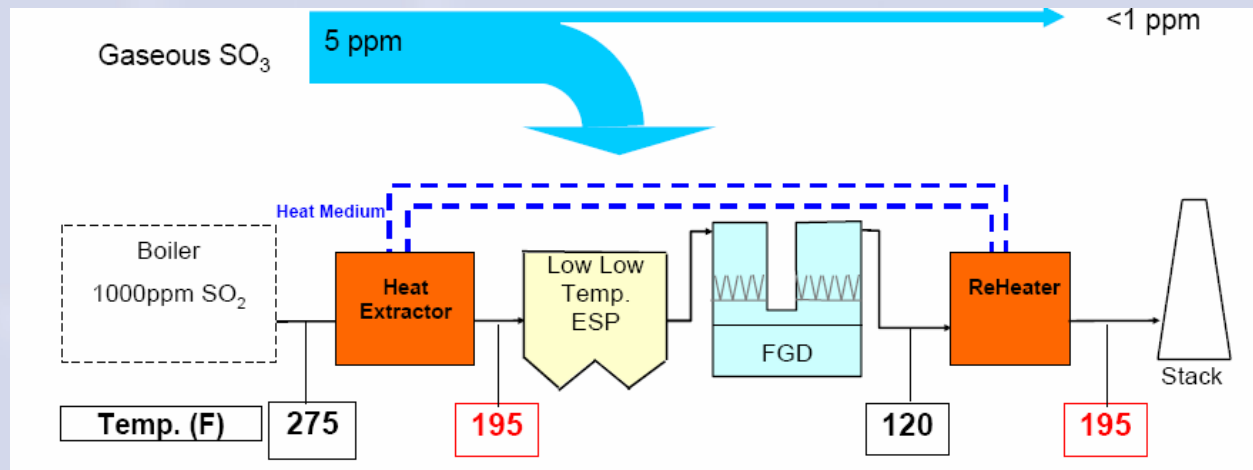
- Most water consumed in coal-fired power plants by evaporative losses
 - Cooling towers- 90%
 - Wet FGD systems- 10%
- Recent EPA regulations- CAIR
 - Add 82-GW of FGD capacity by 2020
 - Added FGD capacity will consume 120 MGD
 - Enough to satisfy water needs for 1 million people
 - Or total water demands for 7-GW of new capacity

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Effects of Lower Flue Gas Temperature

- Regenerative heat exchange used in Europe and Japan
- Mitsubishi Heavy Industry (MHI) High Efficiency System in Japan (US Patents 5282429 & 6149713)



Effects of Lower Flue Gas Temperature- Continued

- Potential benefits
 - Lower water consumption in FGD system
 - Control of SO_3 by condensation on ash
 - Improved particulate control by ESP due to reduced gas volume and lower ash resistivity
 - Avoided costs for flue gas reheat or wet stacks
 - Potential reduction in native Hg removal in ESP
- Not demonstrated commercially in US
 - Concerns on cost effectiveness, and
 - Potential increased corrosion rates

Effects of Lower Flue Gas Temperature- Continued

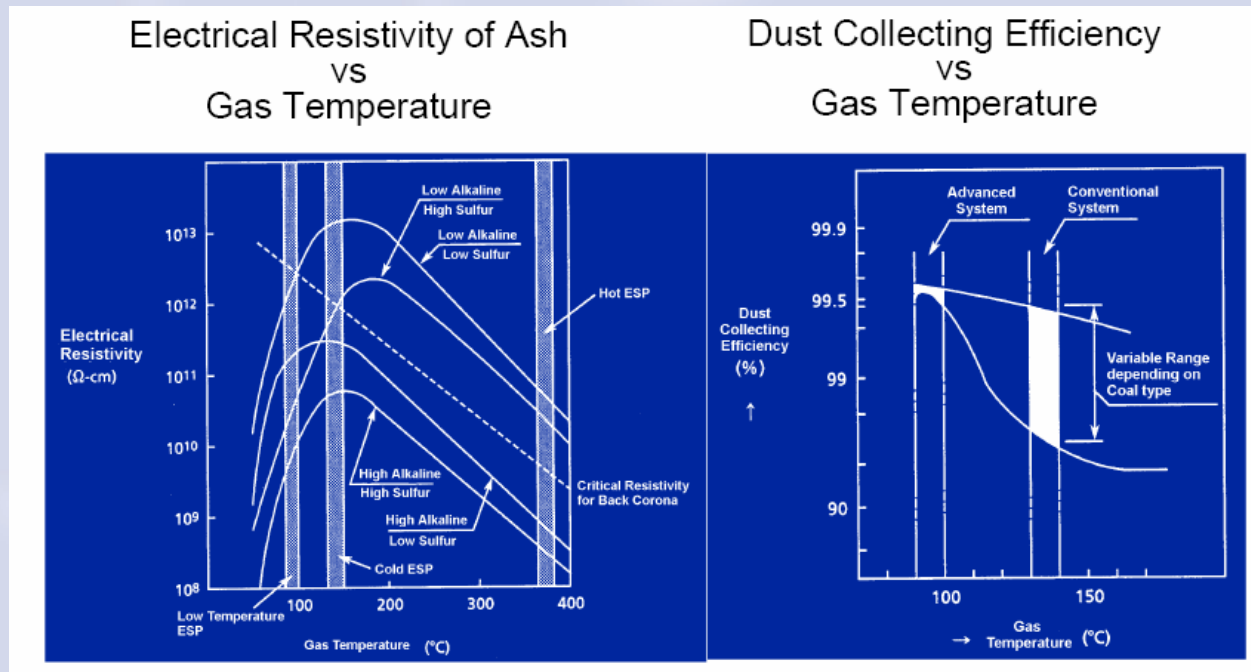
- Minimum flue gas temperature $\sim 120^{\circ}\text{F}$ (FGD outlet) eliminates water evaporation
- Practical limit to reduction of FGD evaporation
 - ESP performance (re-entrainment)
 - Cost of regenerative heat exchanger
 - Materials of construction (carbon steel)
 - Larger size required to lower temperature
- May limit flue gas temperature reduction to $\sim 200^{\circ}\text{F}$ or reduce water consumption by half
- Trade-offs will be investigated in this project

Effects of Lower Flue Gas Temperature- Continued

- Condensation of SO_3 on fly ash
 - Avoid opacity problems
 - Reduce SO_3 without additives or stand-alone controls
 - Inhibit corrosion rates in SO_3 dew point environment
 - Carbon steel heat bundle can be used
- Corrosion tests to be conducted in pilot program to collect corrosion data

Effects of Lower Flue Gas Temperature- Continued

- Improved ESP performance at lower temperature
 - Lower gas velocity and higher specific collection area
 - Lower fly ash resistivity



Effects of Lower Flue Gas Temperature- Continued

- Theoretical ESP performance
 - Particulate collection could improve in retrofit applications
 - Greatest benefit could be for low-sulfur coals which typically have higher resistivity ash
- Non-ideal ESP Performance (Cannot be modeled)
 - Re-entrainment of fly ash at lower resistivity
 - Flue gas flow “scrubbing” collected particles from plates
 - Re-entrainment during rapping
 - Ash resistivity below “ideal” range

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Project Team

- URS Corporation- Prime Contractor
- Southern Company
- Electric Power Research Institute
- Tennessee Valley Authority
- Mitsubishi Heavy Industry
- Southern Research Institute

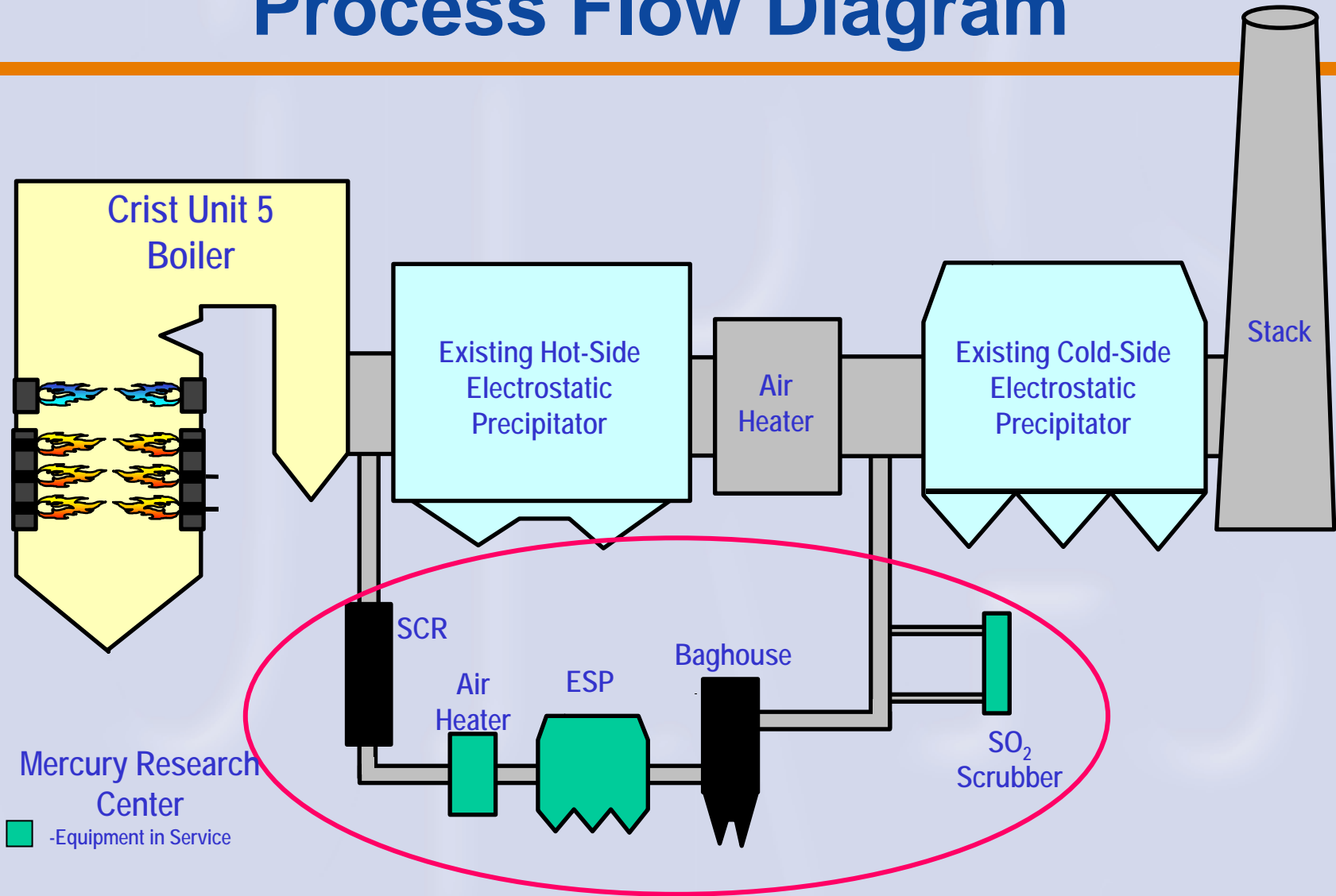
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Project Technical Approach

- Pilot Testing to be conducted at Southern Company's Mercury Research Center (MRC)
 - Located at Gulf Power's Plant Crist near Pensacola, FL
 - Operated by SRI
- MRC processes flue gas slipstream from Unit 5
 - Firing low-sulfur bituminous coal
 - Flue gas flow rate 50,500 lb/hr (5-MW)
 - Ljungstrom air heater
 - Four-field ESP
 - Wet FGD
 - Capability to Inject SO_3 (simulate high-sulfur operation)
- Construct smaller skid-mounted heat exchanger for long-term corrosion tests (3,600 lb/hr)

Mercury Research Center Process Flow Diagram



Mercury Research Center Pilot Unit

**Plant Crist Unit 5
Hot-Side ESP**

**Mercury
Research
Center**



**Plant Crist
Unit 6**

Integrated Pilot Tests

- Baseline tests at typical flue gas temperature
- Parametric tests
 - Vary flue gas temperature
 - Spike SO_3 up to 30 ppm
 - Assess impacts
 - FGD system evaporation rates
 - ESP performance- particulate and Hg removal
 - Simulate operation for higher sulfur coal or plants with SCR
- Select conditions for optimum operation
 - Without SO_3 spiking- minimize FGD water consumption
 - With SO_3 spiking- maximum acceptable SO_3 level

Pilot Measurements

Measurements	Location
FGD evaporative water consumption	Make-up water rates and measurements of liquid levels in reagent and slurry tanks during the duration of each test.
SO ₃ concentrations (CCS)	AH and ESP outlets
Particulate loading (M17)	AH and ESP outlets
Total Hg concentrations	AH and ESP outlets by carbon tube (screen overall Hg removal); coal (baseline only), ash & FGD solids and liquids (verify mass balance)
LOI of ash	ESP ash
Fly ash resistivity	ESP inlet

Corrosion Tests

- Small pilot heat exchanger- carbon steel
- Long-term test- 6 months
- Select test conditions from Integrated Tests
- Determine if corrosion rates are excessive at low flue gas temperatures
- Collect data on corrosion rates and SO₃ levels

Assess Benefits and Costs

- Estimate water use reduction for existing and future FGD systems
- Investigate commercial alternatives for heat exchanger and associated costs
- Estimate ESP performance in retrofit applications
- Determine if additional SO₃ control is required
- Evaluate impacts on Hg removal
- Compared cost to flue gas reheat and wet stacks
- Collect data on corrosion rates and SO₃ levels
- Estimate potential application to population of existing boilers

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Project Schedule

Task	Schedule
1- Project Planning	July-September, 2006
2- Pilot Plant Assembly	October 2006- July 2007
3- Integrated Pilot Tests	August 2007- November 2007
4- Corrosion Tests	December 2007- May 2008
5- Cost/Benefit Analysis	February 2008-August 2008
6- Management and Reporting	July 2006- August 2008